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ABSTRACT

Preschoolers in a model preschool designed to develop children's planning and problem-solving abilities were compared to children in three comparison preschools on measures assessing children's ability to solve problems and plan. Children were also compared on other measures of cognitive ability, including measures of general cognitive functioning, vocabulary IQ, and Piagetian developmental level. All children attended private, suburban, middle-class preschool programs. Findings indicated that children participating in a model preschool designed to develop planning and problem-solving abilities scored significantly higher than children in comparison preschools on measures constructed to assess those abilities. No differences between preschools were found on the other, more diverse measures of cognitive ability. (RH)

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A Planning and Problem-Solving Preschool Model: The Methodology of Being A Good Learner

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Abstract

Preschoolers in a model preschool designed to develop planning and problem-solving abilities were compared to children in three comparison preschools in terms of measures assessing these abilities. They were also compared on measures of cognitive ability unrelated to the intervention, including a measure of general cognitive functioning (the K-ABC), vocabulary IQ (the PPVT-R) and Piagetian developmental level (a number conservation task). All children attended private, suburban, middle-class preschool programs. A significant difference was obtained between the children in the model preschool and those in the comparison preschools in terms of both planning and problem-solving abilities. No differences were found on the cognitive abilities unrelated to the intervention. Although the use of a quasi-experimental design requires caution in interpreting these findings, they suggest that for middle class children, classroom interventions which stress planning and problem-solving activities may have specific impacts on related cognitive abilities.

A Planning and Problem-Solving Preschool Model: The Methodology of Being a Good Learner

Preschool experiences are critical for young children because they provide the first contact with a school environment. The children's understanding of their role as a learner is being formed within this environment. Therefore, one of the major focuses of a preschool program should be to help young children develop effective methods of approaching school learning. Two important processes in effective school learning are: 1) problem-solving, and 2) organization and planning.

In the present study, a model preschool developed specifically to facilitate these processes was compared to traditional preschool programs. All of the children in each of the preschools were four- and five-year-olds, and all were in classrooms in private nonprofit preschools which provided the transition-to-kindergarten. The preschools were from the same upper middle class suburban area with one comparison center matched in terms of religious and organizational affiliation, and the others matched in terms of location. Thus, the families in the schools were similar in terms of demographic factors.

The key question in the study was whether programs with a planning and problem-solving focus can have an educational impact on these specific cognitive processes in preschoolers, above the effect of traditional open education preschool programs. Comparison classrooms were selected which were as similar as possible to the model classroom, except for the specific interventions employed in the model classroom. Matched comparison groups are preferable to unrelated comparison groups in quasi-experimental designs because they control for extraneous sources of error variance. Thus, they are more powerful in

revealing the specific effects of an intervention than unrelated comparison classrooms which vary simultaneously along a number of different characteristics, making it difficult to pinpoint the critical components of the intervention.

To evaluate the model preschool, end of school year performance was assessed in terms of planning and open-ended problem-solving. It was predicted that children in the special program would outperform the children in the other preschools on these measures. It was further predicted that the children in the model preschool would not differ from the comparison children on cognitive abilities unrelated to the intervention. This is important because one potential bias in a quasi-experimental design is lack of random sampling with the possible confounding effect of higher overall cognitive functioning among children in the intervention group (Cook & Campbell, 1979).

To test for this possibility, the children in the model preschool were compared to those in the other preschools in terms of general IQ (the Kaufman Assessment Battery for Children, the K-ABC), vocabulary IQ (the Peabody Picture Vocabulary Test, the PPVT-R), and Piagetian developmental level (a number conservation task).

Theoretical Rationale for the Model Preschool

The model classroom had characteristics in common with the comparison classrooms which were traditional open education preschool programs. As is typical of traditional preschools, the physical design contained learning centers, and the day was organized around free play, and both large and small groups in all the programs. The philosophies of all the programs were developmentally-based and influenced by Piagetian theory. However, while

open education preschool programs are influenced by Piagetian theory, their primary focus is on the whole child with greatest stress on social-emotional development (Morrison, 1988). In contrast, the model preschool program was substantially more cognitively-based. The goal of this program was to develop thinking skills in the children in terms of logical, organized thinking as well as creative problem-solving.

Two major cognitive theoretical approaches were important in the development of the model classroom. The first was a Piagetian approach with its focus on children's thinking processes and on the active construction of knowledge (Hohmann, Banet, & Weikart, 1979). The second was an information processing view with its focus on executive competence in terms of effective decision-making, planning, and learning strategies (Sternberg, 1984). Although these two theoretical approaches are often presented as if they were in opposition to one another, there are a number of ways that they are convergent (Gross, 1985). Both theories focus on mental operations, i.e. on processing of information, rather than on the outcome behavior. Thus, both are concerned with how children go about solving problems, on the strategies they use, rather than on whether they obtain the right answer. Both perceive the learner as an active contributor to the learning process (e.g. assimilation/ accommodation of schemas from a Piagetian perspective and executive decision-making from an information processing prospective). Finally, both study developmental changes in the rules which children use in solving problems.

The design of the model program was most strongly influenced by two Piagetian preschool models. The problem-solving focus of the Sigel model (Copple, Sigel, & Saunders, 1979) and the planning focus of the Weikart High/Scope model (Hohmann, et al., 1979) were important in the development of the model. The information processing approach was influential both as a theoretical framework and as the basis for measuring behavior in the study. Aspects of the inquiry educational models of Bruner (1968) and Suchman (1966) were useful in applying this approach to the present model preschool.

Unique Elements of the Model Preschool

There were a number of unique elements in the model classroom based on problem-solving and planning, which were not present in the more traditional open education comparison classrooms. These elements are described below:

Problem-solving activities. Once a day small group sessions were designed around problem-solving. In addition to this daily exposure, at least twice a week the large group sessions were given over to problem-solving activities. These large and small group activities were designed to develop planning and problem-solving ability through the inquiry method (Eggen & Kauchak, 1988), with problems posed across all curriculum areas. The projects focused on sequential, logical planning and problem-solving through the steps of scientific thinking, including careful observation, predicting and testing hypotheses, and evaluation. However, divergent thinking was also encouraged through idea generation. Democratic decision-making, science and social studies problem-solving, redesigning of learning centers, and advance planning for visitors and field trips are examples of some of the small and large group activities in which children participated as part of the model program.

To encourage problem-solving, materials which naturally posed problems such as a dismantled meat grinder, or a magnifying glass next to assorted materials, were available in learning centers around the room. The walls and bulletin boards reflected ongoing and completed problem-solving projects. These included charts with the children's predictions and ideas rather than uniform, product-oriented examples of completed work.

Planning-oriented activities.

A planning board was a key element in the classroom and was not available in the comparison classrooms. This board displayed picture symbols representing the different areas of the room. The children used the board to make decisions relating to choice of learning center by placing their name card on hooks underneath their choice. As the children made their choices on the board they were asked by the teachers what they planned to do in the area of their choice, what materials they planned to use, and where they would find them. Thus, the children were asked to think ahead about their projects.

Large group planning sessions were a frequent component of the model program. When the group reached a decision on a problem, they then would plan how to implement their decisions. For example, when redesigning the dramatic play area, the children would plan out what needed to be removed as well as added to the housekeeping area to turn it into a bakery. They then would plan out where to find the objects to be added to the area.

Methods of Assessing Thinking Skills

A major requirement of the present study was to design ways of meaningfully assessing planning and problem-solving in children at the preschool level. Those measures which have been developed for children this young have

had little relevance to real-life preschool activities (Karmiloff-Smith, 1984). One exception is the classroom observation measure, the Executive Skills Profile, designed by Bronson (1981). When used as part of an evaluation battery to predict later school achievement, this measure did as well or better than other predictors typically used by school systems, such as mother's educational level and cognitive test scores (Bronson, 1981; Pierson, Bronson, Dromey, Swartz, Tivnan, & Walker, 1983; Bronson, Pierson, & Tivnan, 1984). The planning measure used in the present study consisted of a composite score measuring organization, systematic responding, and efficiency in three tasks related to preschool activities. This measure incorporated tasks designed by Bronson (Wallace, Shapiro, Desir, Bronson, Goodson, 1982; Casey, Bronson, Tivnan, Riley & Spenciner, 1988). The problem-solving measure consisted of problem situations posed to the children. These were scored on the number of realistic solutions which were generated.

Methods

Subjects

A total of 68 children (31 males and 37 females) participated in the study, with 19 in the model preschool and 49 in the other three schools combined. Consultants from a nearby university were involved in the design of the curriculum in the model preschool. The majority of children in the model preschool had attended traditional preschool programs for three-year-olds at the same preschool site. Thus, for most parents, choice of the model preschool was based on continuation of their child at the same center rather than on the elements of the model.

All four classrooms had two one-day-a-week student teachers from the university in their classrooms. All of the schools were private preschools located in the same middle class suburban area of Boston, MA. The subjects ranged in age from 4 years 0 months to 5 years 8 months (model classroom, M age = 4 yr. 11 mos.; comparison classroom 1, M age = 4 yr. 10 mo.; comparison classroom 2, M age = 4 yr. 11 mo.; comparison classroom 3, M age = 5 yr. 1 mo. All children had attended their transition-to-kindergarten preschool program for at least six months. None of the children had any known handicapping conditions. Each subject was tested individually at the end of the academic school year using three trained testers.

The Planning Measure

The planning measure consisted of a composite Z score based on three tasks, the Animal Stalls Task, the Seriation Task, and the Story Sequence Task. The composite score was computed by taking the raw score for each component of the planning measure and converting them to Z scores for each subject. Next, these Z scores from the separate components were added together to make the composite score (none of the subjects performed at ceiling levels on this score). The three tasks are described below.

The Animal Stalls Task, designed by Wallace, Shapiro, Desir, Bronson, & Goodson (1982), is similar to construction and block play activities found in the comparison classrooms as well as the model classroom. It involves replicating a block construction from a model. The model is a block structure consisting of "stalls" with miniature animals and hay bales. The child must gather the relevant blocks from a larger array on a small shelf, arrange an appropriate work space, and copy the model exactly. The children are instructed that the construction should look "just like" the original.

The planning construct used in the present study for Animal Stalls has three components: organization, systematic approach, and efficiency. While the children perform the task, raters record behaviors which fit these three components and also record the children's sequence of block placements. Prior to the present study raters were trained to 90% accuracy in recording children's behaviors and scoring each category.

Categories in the organization component demonstrate planfulness by providing evidence of an organized approach to a task. Subjects receive points for gathering relevant materials, choosing an appropriate work site, and grouping materials in a way that facilitates accomplishment of the task. Children who score low in this area have difficulty foreseeing the requirements of the tasks. They do not have the right materials at hand, or if the materials are there, they are not arranged in a way that facilitates task-accomplishment. The child might be sitting on needed blocks or have placed them out of sight, or have jumbled materials in a pile so they are difficult to distinguish. Low scoring children also typically attempt tasks in spaced which are not big enough, are in the way of something else (like their own feet or a table leg), or are facing the wrong direction.

For the systematic response component of planning, categories of behaviors are recorded which indicate a systematically correct approach to the task. The child demonstrates planfulness by receiving a point each time they follow a clear and organized sequence of placement of blocks. Children who score low in this area seem to be using a trial and error rather than a planned approach. One placement of a block bears little relation to the next placement and there is seldom any discernible direction in these children's activities.

The efficiency component records the child's number of systematically correct responses in block placements after subtracting moves which are corrections of past mistakes. This provides an estimate of how closely the child's performance approximates an optimal performance, i.e. the minimum number of trials to solution. Children who score low in this area often appear to have a plan, but seem to lose track of it at various points or to make careless mistakes. The efficiency component was included so that a child who alternated between working systematically for a while and reverting to trial and error responding did not obtain as high a score as a child who was able to complete the task in an orderly way throughout, building up the stalls in a logical manner and clearly showing preplanning.

To compute a total planning score for the Animal Stalls Task, the scores for organization, systematic approach, and efficiency are combined for a total score (standardized to a Z-score). (Distributions for these scores were approximately normal and Cronbach's Alpha for the total Z-score was .89.)

The Seriation Task, designed for this study, requires the child to seriate ten small cylinders with a difference in height of approximately 2.5 cm between pieces, and the materials are similar to toys and manipulatives found in preschool classrooms including both the model classroom and the comparison classrooms. The children are shown the cylinders in a seriated "stair" form, then the pieces are mixed and they are asked to make a stair just like the one they have seen. The planning construct for this task consists of an efficiency measure of the number of cylinders placed in a sequenced order minus the number of attempts. Thus, trial and error responses are not counted.

The Story Sequence Task, designed for this study, is based on the picture sequence task in the WISC, and is related to cognitive abilities involved when looking at picture books and storytelling, which are present in both the model classroom and the comparison classrooms. The children are given six sets involving three pictures, each in random order, and asked to put the pictures in the right order to tell a story, and then to tell the story. Both the picture sequence and the verbal account are scored for evidence of planning. Subjects receive one point for showing evidence of planning if they get the first picture in the correct order on the first attempt. In order to receive additional credit they have to place the next two pictures in correct order (two points) on the first attempt. They do not get credit for correct placement following trial and error. On the storytelling component, the children's responses are audio-taped. Every logically sequenced statement is scored as correct. The statements have to follow logically and make sense in relation to the pictures. Both the picture ordering and story telling scores are added together to form a composite score (standardized to a Z-score). (Distributions were approximately normal and Cronbach's Alpha for the composite score was .78.)

Rationale for the planning tasks. The planning score should correlate highly with success on the tasks. This would be expected, since correct responses on the tasks should depend in part how planful and organized the children are. However, the correlations should not be perfect, since some children might obtain the correct answer through trial and error rather than through systematic planning strategies. The Animal Stalls Composite planning score correlated .69 with total number of correct responses, the Seration

planning score correlated .82 with total correct, and the Story Sequence planning score correlated .86 with total correct.

The Animal Stalls, Seriation and Story Sequence tasks were selected to assess planning because they could be analyzed to determine whether forethought and planning was used by the children. Many standard assessment tasks are not appropriate for this type of analysis because the subject either immediately knows or does not know the answer (e.g. comprehension and vocabulary questions on IQ tests). The tasks used to assess planning must allow for evaluation of strategies.

The Problem-Solving Measure

The Realistic Problem-Solving Task, designed for this study, is used to assess solutions to hypothetical problems. Since the number of possible solutions are open-ended, no subjects can perform at ceiling levels on this task. Subjects are given three situations and asked to generate solutions. The situations are either ones which would be equally likely to be confronted in the model or comparison classrooms, or equally novel in both types of classrooms. The following three situations are included: 1) You are outside playing and you decide you would like to play on that swing. But, there is a problem. There is a big puddle under your favorite swing. Your teacher said you can swing on that swing if you don't get wet. What can you do if you really want to swing on that swing? 2) You are making a picture book with many pages for your parents. You try to use the stapler, but there are no staples in the stapler. What do you do if you really want to put the book together? 3) You are in a room and you have a piece of gum stuck in the middle of your back. Your arms are not long enough to reach it. What can

you do to get that piece of gum off your back? After each solution to a situation, subjects are probed for additional solutions. Their responses are rated and they are given one point for each realistic solution to the situation, and these are totalled across situations for a combined score. In this study, each child's performance was scored by two separate raters. Inter-rater agreement was in excess of 90% accuracy for each problem.

Rationale for the problem-solving task. This particular problem-solving task was selected because it was an open-ended type of task where more than one solution is possible rather one-solution problems typical of those found on IQ tasks. Furthermore, this problem-solving task was selected because it includes items that assess the types of problems commonly encountered in preschool classrooms.

General Intelligence Measures

Three different types of tests were used to measure general cognitive functioning. The Peabody Picture Vocabulary Test - Revised (PPVT-R) consists of a series of matching tasks in which the subject has to point to one of four objects on a page in response to a verbal stimulus. This test is a measure of receptive vocabulary and provides an index of English vocabulary achievement (Dunn & Dunn, 1981).

The Kaufman Assessment Battery for Children (K-ABC) defines intelligence as the ability to solve problems using simultaneous and sequential mental processes (Kaufman & Kaufman, 1983). It is a new IQ test which correlates highly with standard IQ tests (Kaufman & McLean, 1987). The simultaneous processing scale contains tasks which are spatial or analogic and the child must simultaneously integrate and synthesize the information in order to solve

each problem. For example, in the face recognition subtest the child has to pick a face out of a group picture and in the triangles subtest the subject has to assemble several identical triangles into an abstract pattern to match a model. The sequential processing scale presents tasks which the child must solve by arranging the stimuli in sequential order. For example, in the number recall subtest the child must repeat a series of digits and in the word order subtest the child has to touch a series of silhouettes of common objects in the same sequence as the examiner says the names of the objects.

The third measure of general ability was a Piagetian task assessing concrete operations thinking. The Number Conservation Task was selected. The test was administered using a procedure similar to the one by Piaget described in Inhelder, Sinclair, and Bovet, (1974), with the exception that five rather than seven checkers were used in each row (Gelman, 1969). Using this procedure the children are shown two rows of five checkers one under the other, with one row red and one row black. When the children agree there is the same number of checkers in both rows, the experimenter modifies the lay-out by spacing out the checkers in one of the rows so it forms a longer row and asks "Are there as many, the same number of black ones as red ones or aren't there? Or are there more? How do you know? Then the red checkers are put in a circle and the black checkers are put in a row and the question is repeated. Two points are given when correct responses and explanations are obtained on the two trials, and one point is given when a correct response and explanation is given on only one trial.

Results

First, a preliminary analysis was performed which made comparisons among the three comparison preschools. The purpose of this analysis was to determine whether the comparison groups showed differences on the planning and problem-solving measures. Using a one-way ANOVA for each measure, no significant differences were found among the three groups for either the planning or the problem-solving measure. Consequently, it was possible to combine these groups and compare them to the model preschool on subsequent analyses.

To address the main questions in the study, two ANOVA's were performed. First, a 2 x 2 ANOVA, type of classroom (model vs comparison) by sex (male vs female), was conducted on the composite Z-score measure of planning. A significant main effect of type of classroom was obtained, F (1, 63) = 10.69, p = .002. The model preschool (M = 2.30, $S.D.$ = 3.47) showed a higher planning score than the comparison classrooms combined (M = -.87, $S.D.$ = 4.34). No other main effect or interaction was significant for this analysis.

Next, a 2 x 2 ANOVA, type of classroom (model vs comparison) by sex (male vs female), was conducted on the problem-solving measure. A significant main effect of type of classroom was obtained, F (1,64) = 6.46, p = .013. The model preschool (M = 4.79, $S.D.$ = 2.82) showed a higher problem-solving score than the comparison classrooms combined (M = 3.18, $S.D.$ = 1.54). No other main effect or interaction was significant for this analysis.

Finally, three t-tests were performed comparing the model preschool with the three comparison classrooms combined on measures of cognitive development unrelated to the intervention. The groups were compared on a measure of general IQ (the K-ABC), on a measure of vocabulary IQ (the PPVT-R) and on a measure of Piagetian cognitive level (the number conservation task). None of these comparisons were significant.

Discussion

The present study showed that children participating in a model preschool designed to develop planning and problem-solving abilities scored higher than children in comparison preschools on measures constructed to assess these thinking skills. Clearly these results need to be considered from the perspective that subjects were not randomly assigned to groups, and that university consultants were involved in the model program, possibly producing a general halo effect. Nevertheless, it is encouraging that the children did not differ on diverse measures of cognitive abilities other than those which reflected the basis of the intervention program.

The majority of the research on the effect of specific preschool models has been on children of the poor rather than on middle class children (Schwartz, 1985). Research on Headstart has shown that with a disadvantaged population of children, the pattern of abilities achieved by an intervention program is based on the focus of that model, with a cognitive-developmental program increasing children's problem-solving abilities (Peters, Neisworth & Yawkey, 1985). The present results tentatively suggest that with a middle class population of preschoolers as well, a stress on problem-solving and planning in the curriculum differentially affects these thinking skills but

does not improve more general cognitive abilities any more than traditional open education preschools do. It is interesting that this effect occurred above the impact of the middle-class home environment.

The widely implemented High/Scope model (Hohmann, et al., 1979) has a strong emphasis on children's planning. Yet, there has been little research assessing the effectiveness of such an approach. The present results are consistent with the initial findings of Bronson, Pierson, and Tivnan (1984) that such a focus can make an impact.

Careful observation of children in elementary classroom settings would indicate that there are clear differences in how competent children are in terms of their organizational and planning abilities. These skills are important components of school success. The more behavior appears to be purposeful and systematic (i.e. governed by a plan) the more effectively children can carry out their school assignments. Yet, some children approach tasks with haphazard trial and error strategies which typically do not work or do not work very well. They approach these assignments with little apparent forethought. They may not consider what materials they might need, what kind of work-space would be appropriate, or what series of steps may be required to accomplish the task. If it is possible to develop these planning skills at the preschool level, it would be an invaluable contribution for children's later success in school.

Although planning may be somewhat illogical and disorganized during the preschool years, developing automaticity of planning strategies may be very useful, so that these behaviors are in place when cognitive development reaches the point where more sophisticated planning can occur. In other words, the advantage of teaching planning strategies during the early years

may be to make automatic the process of asking at the outset of a task, "What is my goal for this task, what materials do I need, and what steps will I need to go through to reach my goal?"

Another component of thinking skills which is important for school success and later in life is the development of realistic problem-solving abilities. A key goal for preschool programs should be to foster independent learners who take the initiative to generate solutions to problems when confronted with obstacles rather than giving up immediately and asking for help. It is important to help children perceive these problems as a challenge to overcome rather than evidence of their own personal failure. Throughout their schooling children are frequently taught that they have failed when they do not succeed on the first try. Instead of perceiving a problem as a failure experience, it is important to teach children that "failing" is the first step toward eventual success when trying to solve a problem that is worth tackling. Perhaps if this understanding of their role as a learner is developed within children during their preschool years, it may help to innoculate them against the focus on being "right" or "wrong" frequently emphasized in later schooling.

The verdict on the long-term effects of a cognitive-developmental program which stresses planning and problem-solving is still not in. However, the present results are encouraging about the short-term effects of such a program. Further research in this area on both short- and long-term effects is important, and a key component of this research should be the use meaningful measures relevant to school-related activities.

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